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Summary of the Environmental Protection Agency's Columbia River Temperature Assessment Model

The Columbia River Temperature Assessment Model (the 'Model') was developed in response to a demonstrated need to understand the how major temperature-altering sources contribute to the overall temperature regime in the Columbia/Lower Snake Rivers. The Model predicts temperature along the Columbia River from the Grand Coulee Dam to the Bonneville Dam and along the Snake River from Lewiston, Idaho to its confluence with the Columbia.

The Model is a tool developed to estimate daily-averaged water temperatures in the Columbia and Lower Snake Rivers. The model predicts average daily temperatures, specific to locations along the lengths of the Rivers, but averaged across the width and depth of the Rivers. Some of the key features of the model include: The ability to expand the modeled geographic area eastward, an algorithm that quantifies the uncertainty of the modeled results, and a twenty-one year database of temperature and climate data. The model is based on the energy budget method and uses an extremely efficient numerical solution technique that simplifies the propagation of uncertainty. The model can simulate a 21-year period ofwater temperatures in the Columiba River from Grand Coulee Dam to Bonneville Dam and in the Snake River from its confluence with the Grande Ronde River to its confluence with the Columbia in in under five minutes.

The model also includes a summary of a biological study on salmon and the impacts of temperatures on their various life-stages.

Model Goals

The original goals for EPA's model development were to:

- Develop simulation methods for temperature assessment.
- Estimate uncertainty of water temperature simulations.
- Estimate temperature impacts of dams on the Snake and Columbia Rivers.
- Estimate temperature impacts of tributaries on the Snake and Columbia Rivers.

Model Scenarios

With the above stated goals as a reference point, the model currently analyzes the likelihood of exceeding a particular benchmark temperature (not necessarily water quality standards criteria) at different points along the Columbia and Snake Rivers under three separate scenarios. These three scenarios include:

1. A 21 year record of actual measured tributary temperature input, river flows and regional meteorology, assuming present river management (all dams in place).

2. A 21 year record of actual measured tributary temperature input, river flows and regional meteorology, assuming the absence of all dams downstream from Lake Roosevelt and below the confluence of the Clearwater and Snake River.

3. A 21 year record of actual measured river flows and regional meteorology, assuming the dams are in place and that tributaries contribute water temperatures equal to or less than 16°C.

The purpose of running these scenarios is to determine temperature conditions in the river given the most extreme river management possible, i.e., extremely cool water from tributaries is contrasted with removing the dams.

Model Results

The Report concludes from an analysis of the above scenarios that the average frequency and magnitude of daily-averaged temperature excursions above 20 ^{o}C tributaries are likely to be greater with dams in place than for the unimpounded river. The impact of tributaries on the average frequency and magnitude of daily-averaged temperature excursions is related directly to their size relative to the main stem Columbia and Snake rivers. For the geographical scope included in the analysis, only the Clearwater River in to the Snake River and the Snake River in relation to the Columbia River had a significant impact on the thermal regime of the main stem. The Snake River is the most significant tributary to the Columbia River in terms of its impact on the temperature regime. The Snake River contributes to increases in both the frequency and magnitude of temperature excursions above 20 ^{o}C for scenarios with dams in place as well as for scenarios for the unimpounded river. The Clearwater River provides cool water to the Snake and reduces both the frequency and magnitude of temperature excursions. Constraining the Clearwater River to water temperatures of 16 ^{o}C or less results in significant cooling of the Snake River.

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The analysis of differences between simulated and observed results showed that R^2 for the regression of observed temperatures on simulated varied between 0.91 and 0.97 for the total dissolved gas monitoring data. The standard deviation of the differences was equal to or less than 1.4 ^{o}C. In some cases, the uncertainty of the estimates of frequency and magnitude was of the order of the difference between the mean values for the various scenarios. This implies improvements in both data and systems models are needed to reduce the uncertainty in estimates of water temperature in the Columbia and Snake rivers.